Restoration of Delta Streams:

A Conceptual Model & Regional Guidance for Implementation

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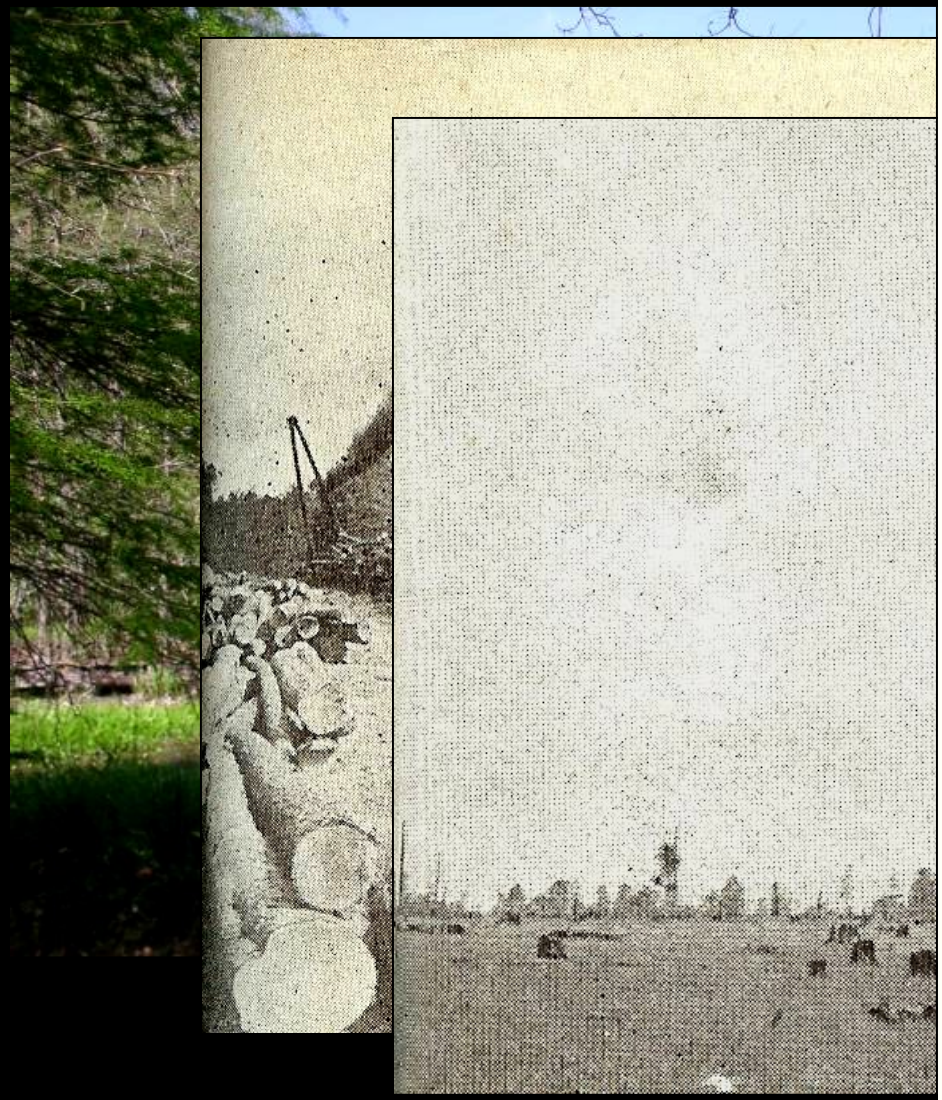
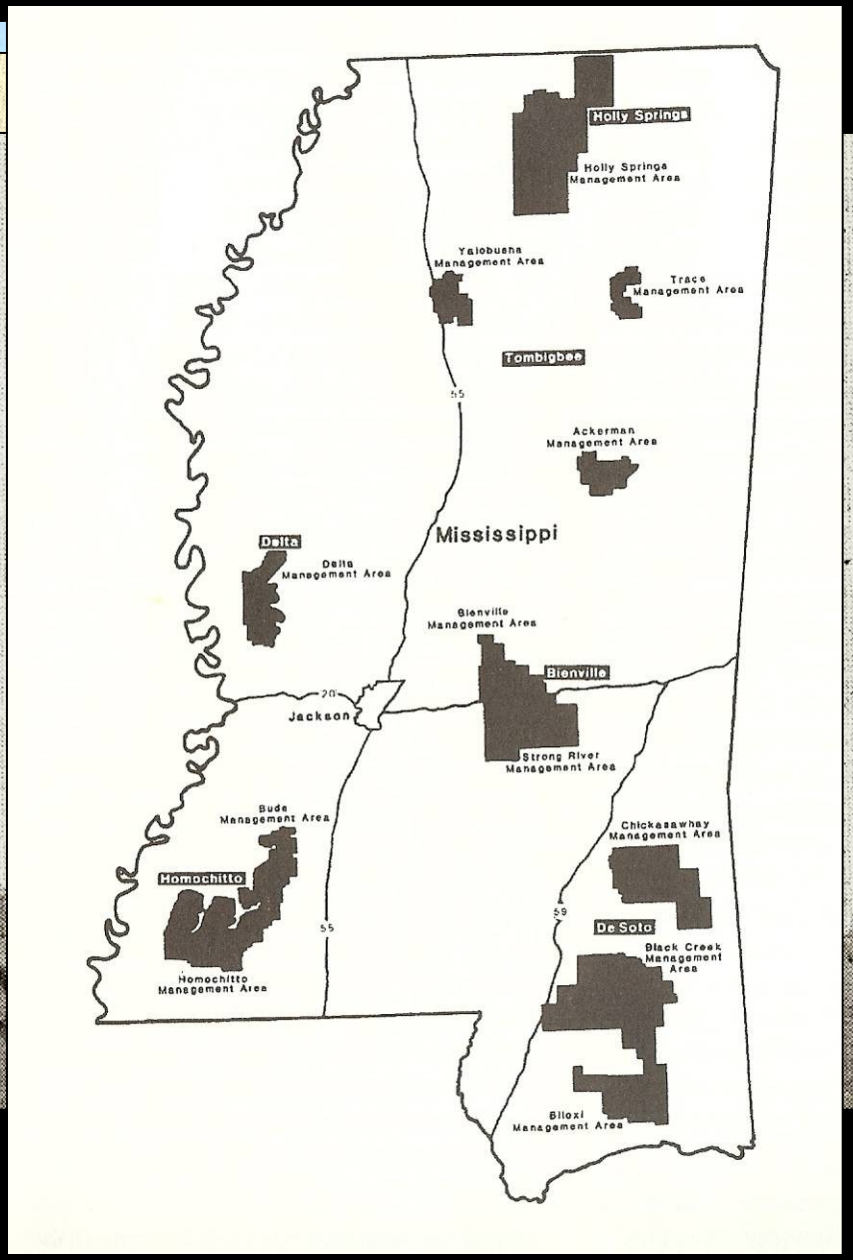
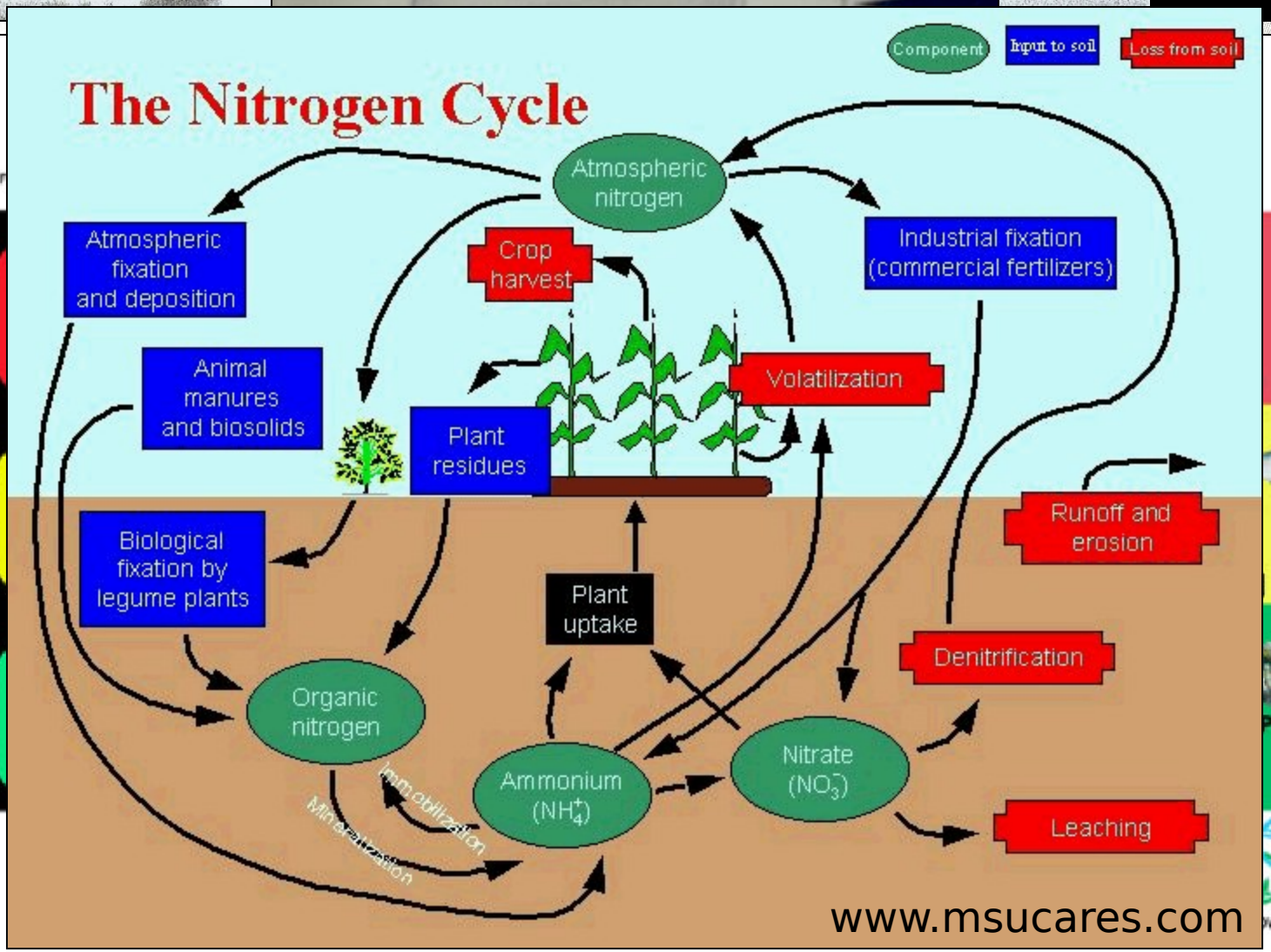
Mississippi Delta: Past and Present





Mississippi Delta: Past and Present



Mississippi Delta: Past and Present

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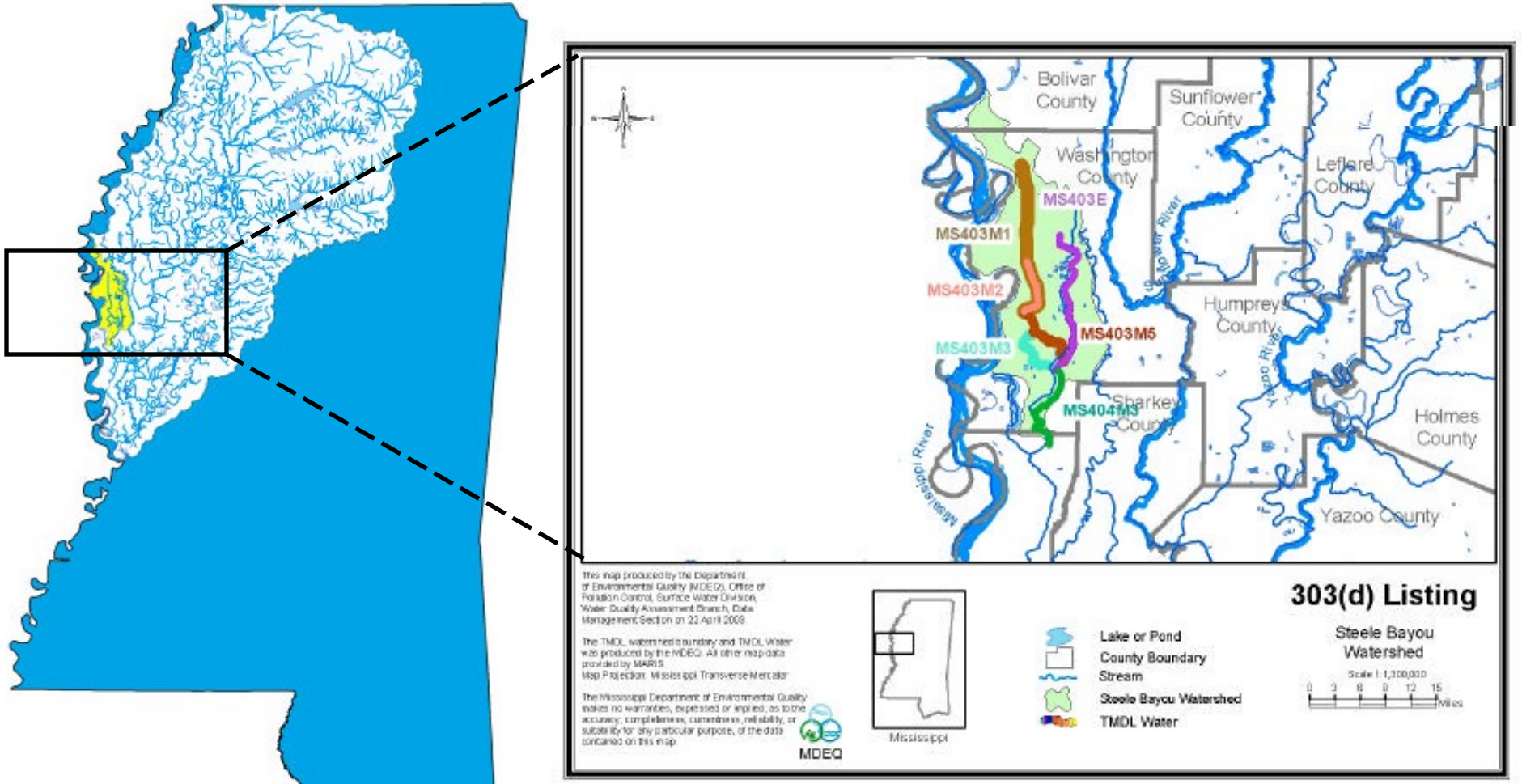
Flood Control Strategies: Incorporating Restoration

- Recognize potential ecosystem benefits of current design
- Identify potential benefits of modified design
- Adapt project plan to balance flood control needs and costs with restoration opportunities
- Collect baseline data pre-project and establish practical restoration goals
- Compare post-project data at *meaningful intervals* to monitor success (studies are necessarily long-term)

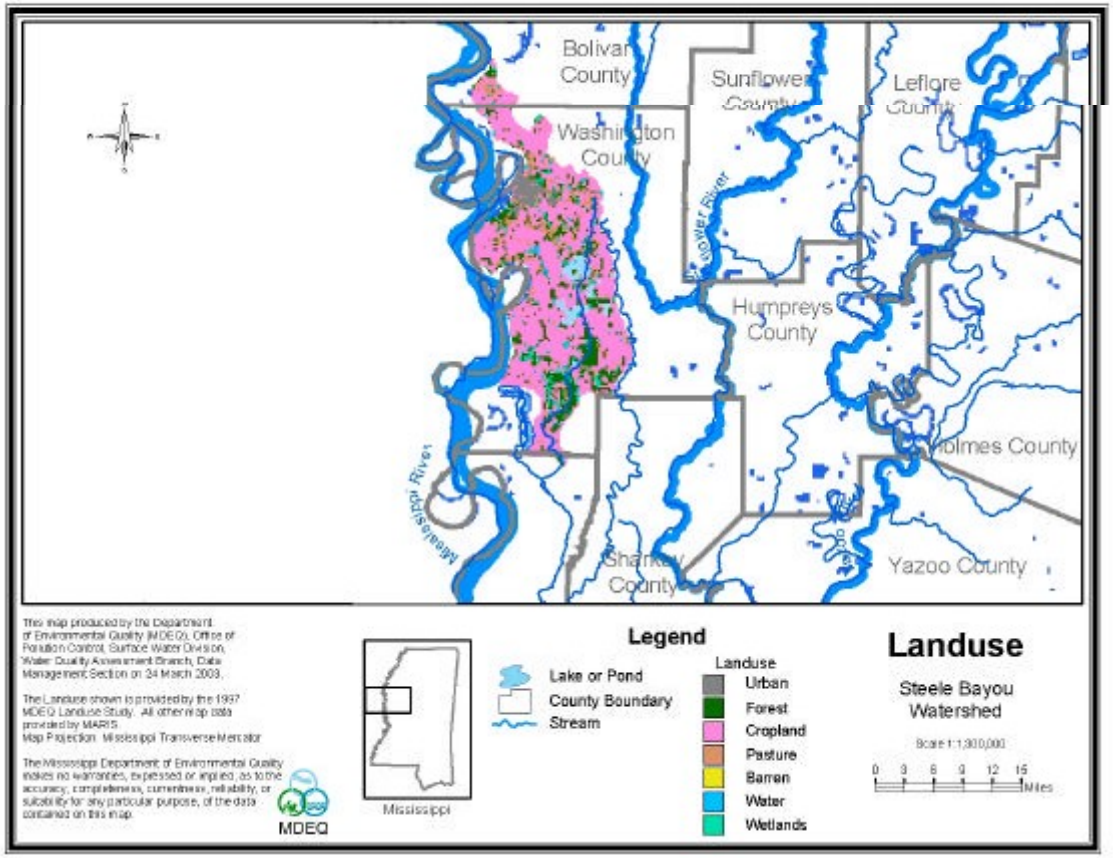
Case Study: Upper Steele Bayou System (USBS)


Bolivar County
Sunflower County
Washington County
Leflore County
MS403E
MS403M1
MS403M2
MS403M5
MS403M3
MS404M3
Humphreys County
Sharkey County
Holmes County
Yazoo County
Mississippi River
Yazoo River
This map produced by the Department of Environmental Quality (MDEQ), Office of Pollution Control, Surface Water Division, Water Quality Assessment Branch, Data Management Section on 22 April 2009
The TMDL watershed boundary and TMDL Water was produced by the MDEQ. All other map data provided by MARIS
Map Projection: Mississippi Transverse Mercator
The Mississippi Department of Environmental Quality makes no warranties, expressed or implied, as to the accuracy, completeness, currentness, reliability, or suitability for any particular purpose, of the data contained on this map
MDEQ
Mississippi
303(d) Listing
Steele Bayou Watershed
Lake or Pond
County Boundary
Stream
Steele Bayou Watershed
TMDL Water
Miles

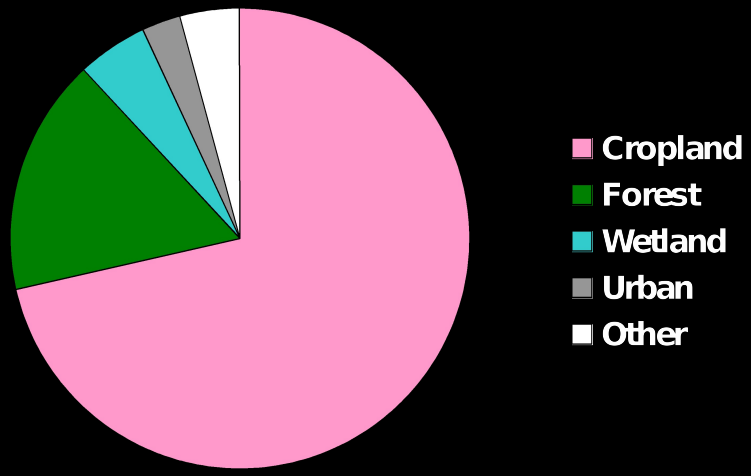
MDEQ

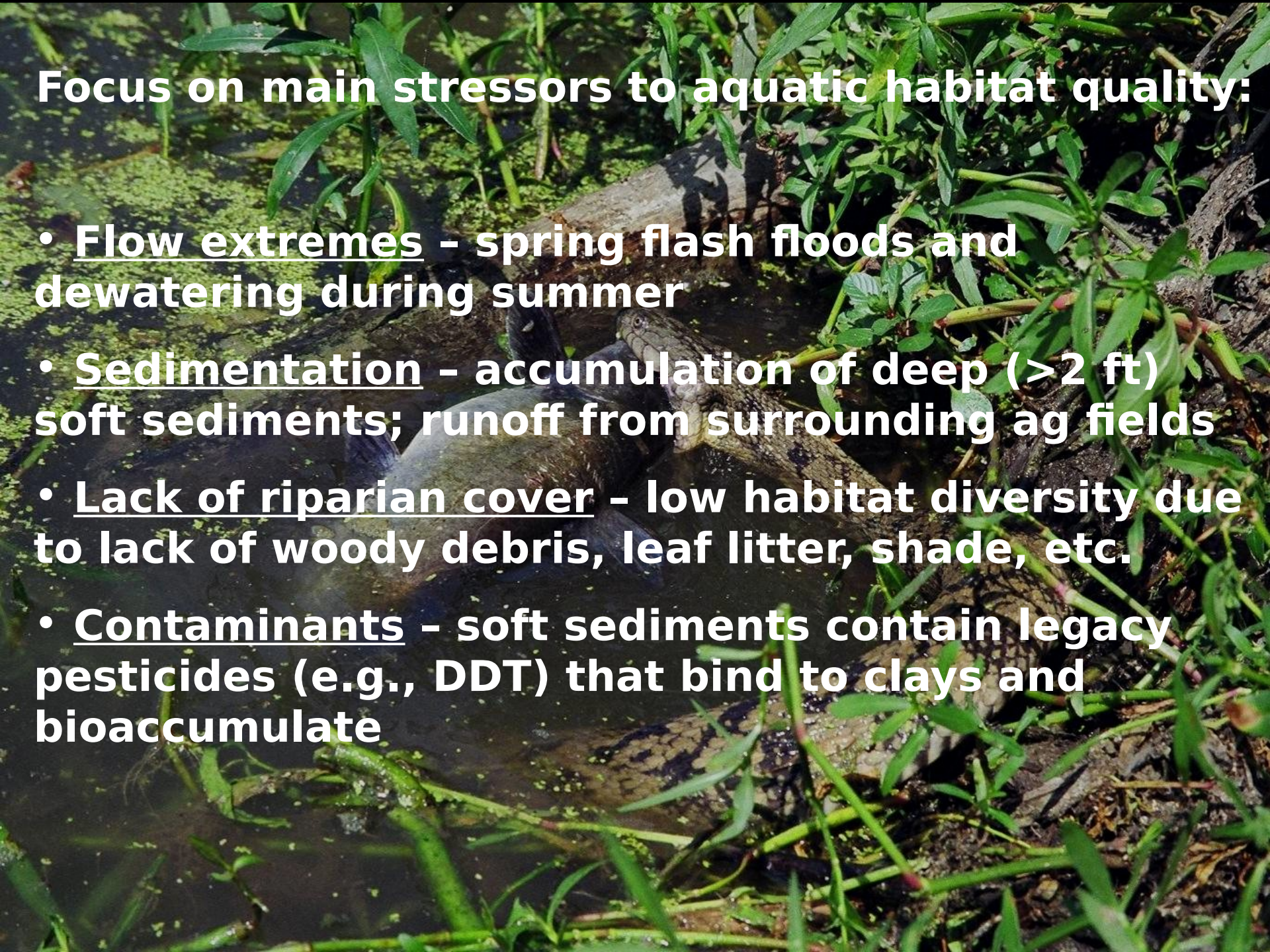
Landuse in Steele Bayou Watershed

(source: MDEQ)



- 71.5% Cropland
- 16.5% Forest
- 5.0% Wetland
- 2.9% Urban
- 4.1% Other





Focus on main stressors to aquatic habitat quality:

- Flow extremes – spring flash floods and dewatering during summer
- Sedimentation – accumulation of deep (>2 ft) soft sediments; runoff from surrounding ag fields
- Lack of riparian cover – low habitat diversity due to lack of woody debris, leaf litter, shade, etc.
- Contaminants – soft sediments contain legacy pesticides (e.g., DDT) that bind to clays and bioaccumulate

Weirs

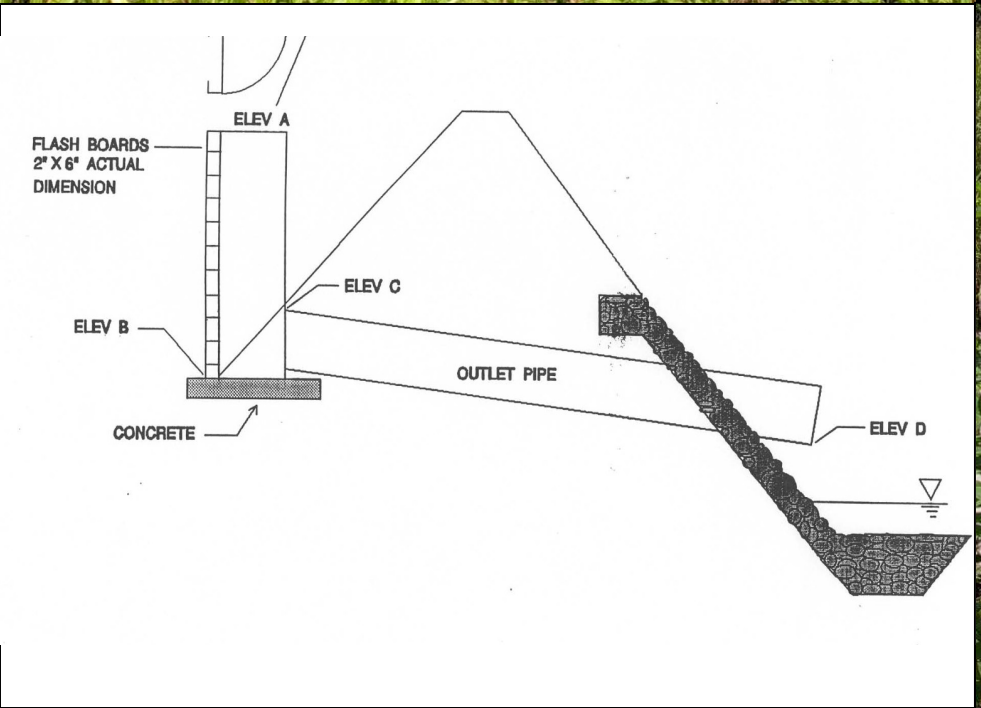
- Pool water above structure during low-flow summer months
- Increase water depth reducing water temperature and increasing oxygen availability above structure
- Provide coarse, stable substrate below structure
- Provide artificial “riffles” below structure maintained by scour

Channel Cleanout

- Increases water depth
- Restores firm substrates for use by benthic feeders and nest builders
- Removes soft sediments that contain legacy pesticides
- Improves flow and water quality

Drop pipe structures

- Slow the velocity of runoff water so that suspended sediment will settle out before entering the stream
- 2-3 ft of fill can accumulate behind the structure in a single season



Narrow riparian buffer strips

- Provide woody debris, leaf litter, shade, and bank stabilization
- Require minimal commitment from landowner

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Upper Steele Bayou Flood Control Project Design Modification

Flood Control Component	Original Purpose	Design Modification & Potential Benefit
Channel cleanout and enlargement	Reduce flood damage by reducing stage	Removal of soft sediment improves habitat quality in low-gradient streams and removes legacy pesticides
Weir construction	Water management and in-stream control of vegetation during low flow season	Low-crest, gradually sloping weirs pool water at low flow, create artificial “riffles” during normal flow, and are passable by fish at high flow

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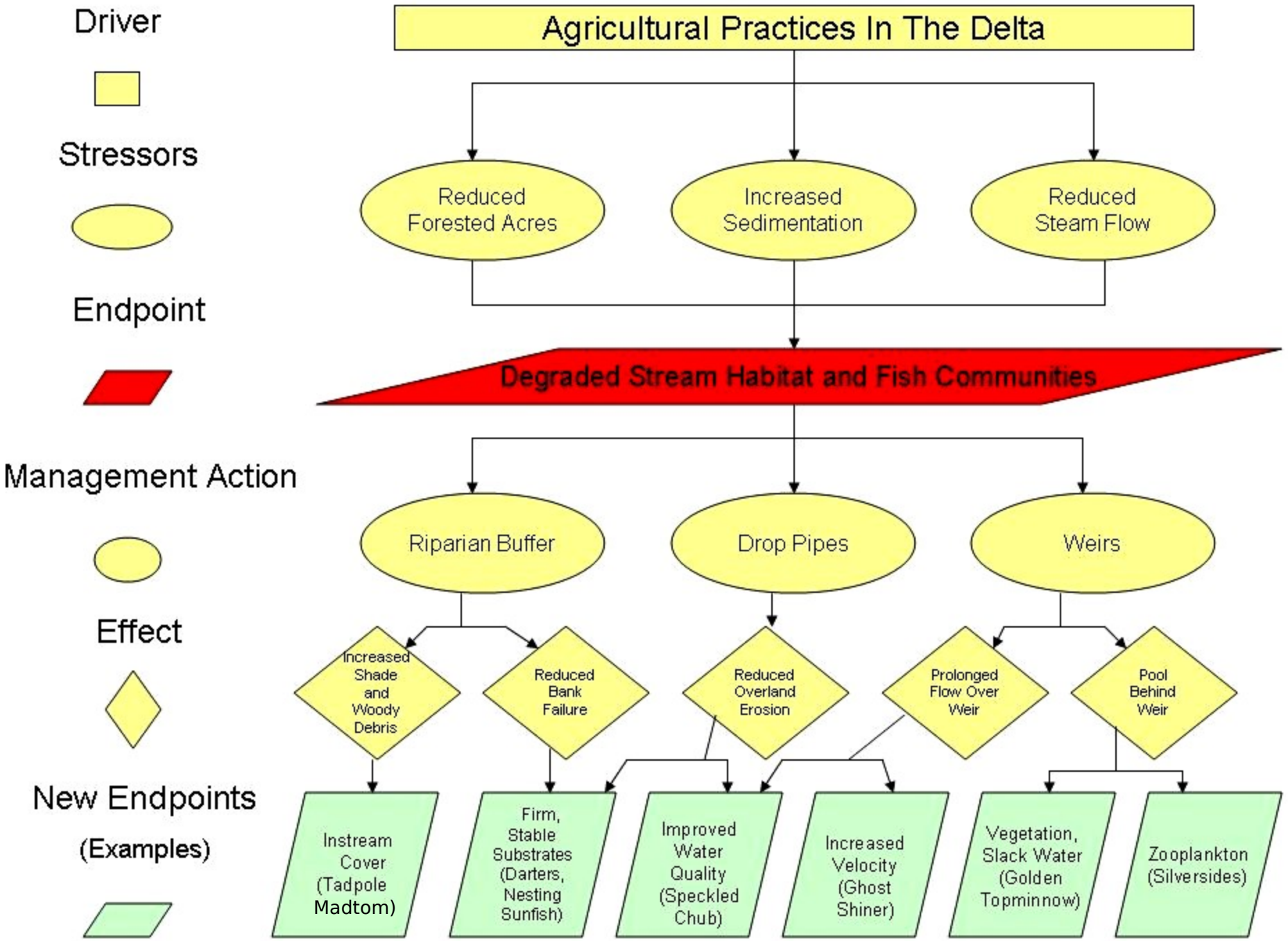
Upper Steele Bayou Flood Control

Additions to Project Design

Restoration Component	Purpose/Benefit
Drop pipes	Erosion control / Prevent sediments from reestablishing in channel after cleanout
Riparian buffer strips	Stabilize stream banks / Improve in-stream habitat quality
Yazoo Wildlife Refuge enhancement for waterfowl	Mitigation / Improve local wetland


Driver
Stressors
Endpoint
Management Action
Effect
New Endpoints
(Examples)
Agricultural Practices In The Delta
Reduced Forested Acres
Increased Sedimentation
Reduced Steam Flow
Degraded Stream Habitat and Fish Communities
Riparian Buffer
Drop Pipes
Weirs
Increased Shade and Woody Debris
Reduced Bank Failure
Reduced Overland Erosion
Prolonged Flow Over Weir
Pool Behind Weir
Instream Cover (Tadpole Madtom)
Firm, Stable Substrates (Darters, Nesting Sunfish)
Improved Water Quality (Speckled Chub)
Increased Velocity (Ghost Shiner)
Vegetation, Slack Water (Golden Topminnow)
Zooplankton (Silversides)

Rarefaction curves: Abundance-based predictions of diversity

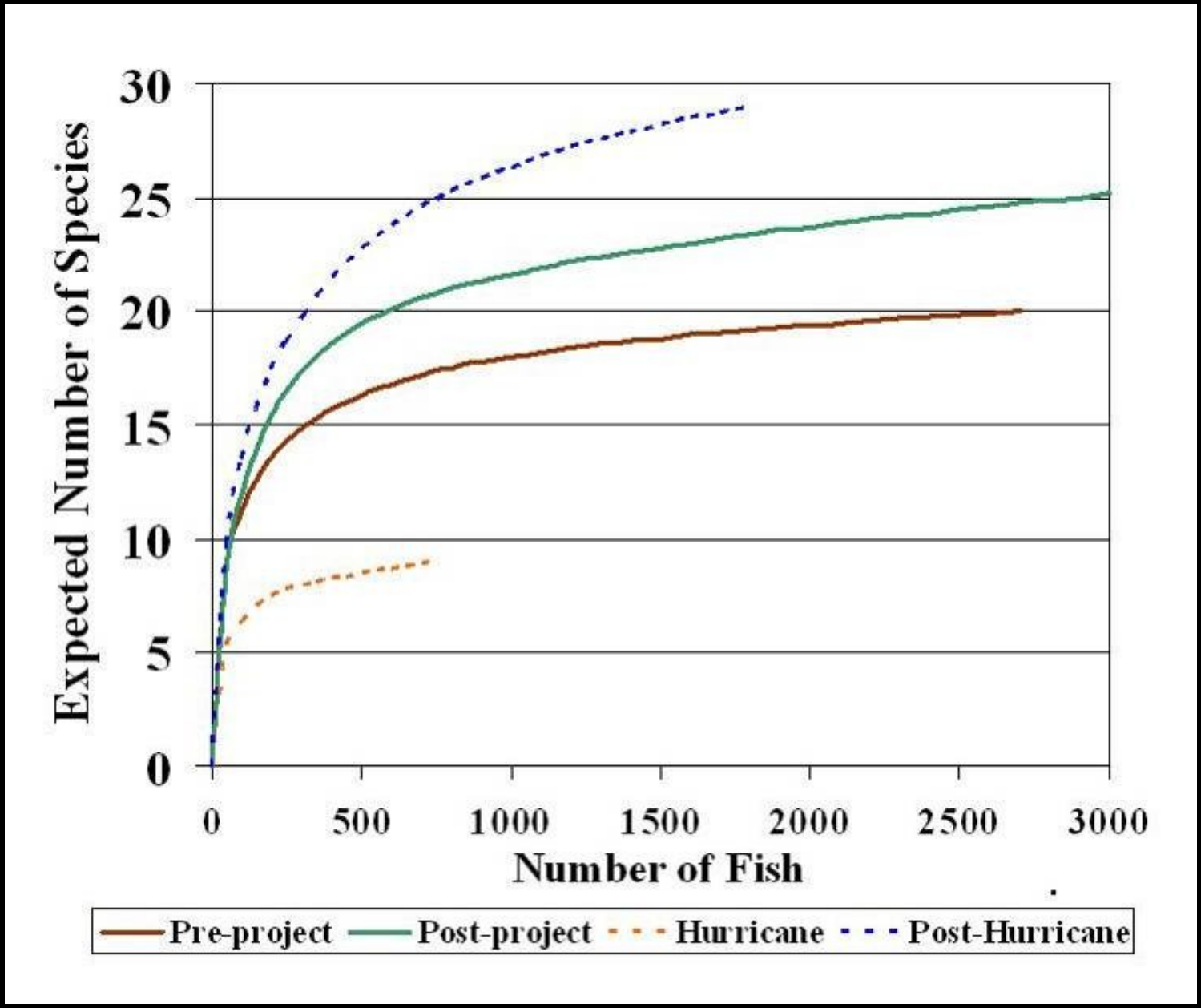


Table 3. Summary of ∑DDT concentrations measured in Steele Bayou sediment and fish tissue.

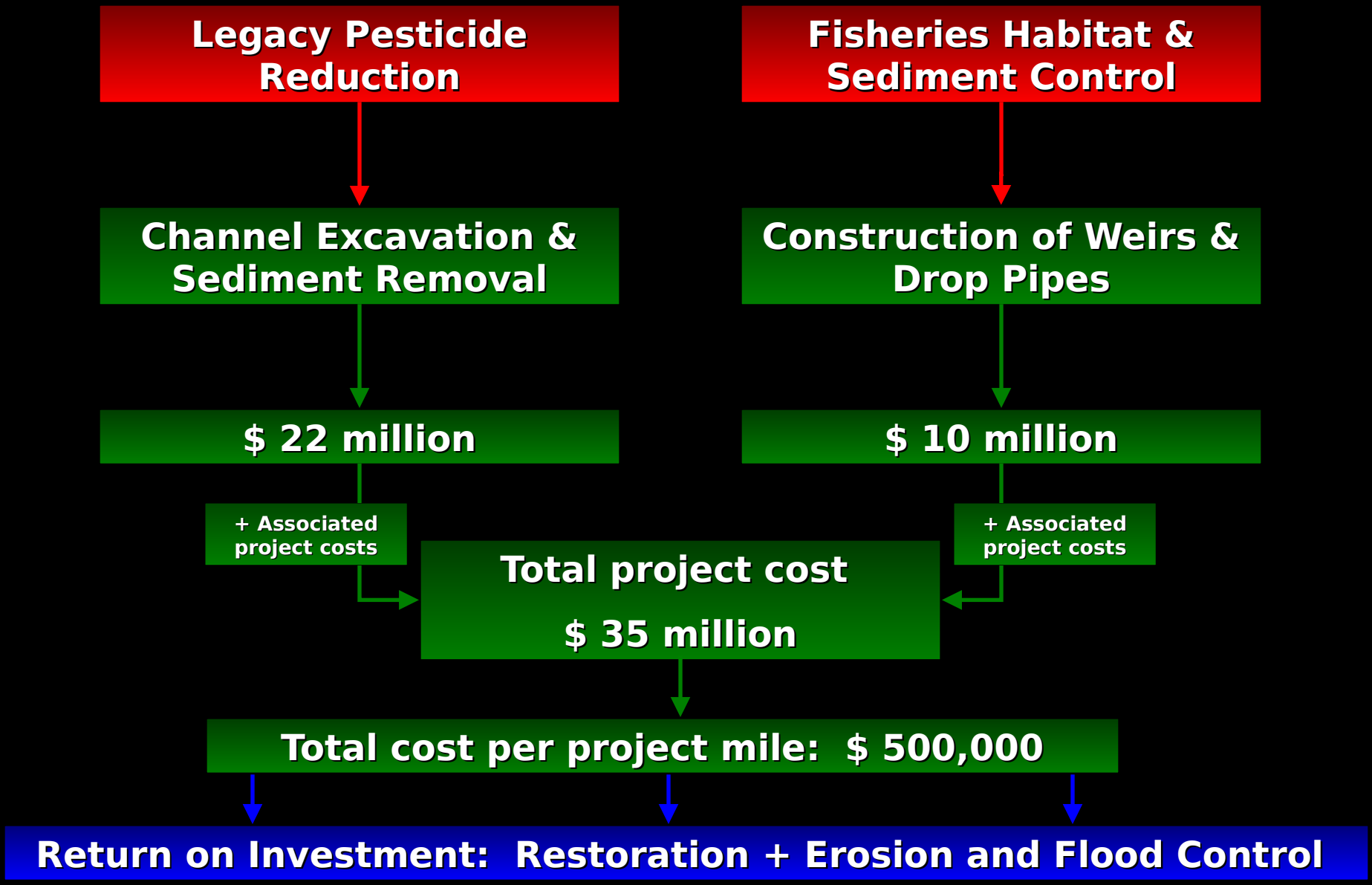
	Sediment				**Fish Tissue**		
	Black Bayou		Main Canal		Steele Bayou		
	Pre-	Post-	Pre-	Post-	Pre- [1]	Post- [2]	Post- [3]
Number	13	20	9	19	32	82	42
Mean ∑DDT (mg/kg)	0.085	0.029	0.163	0.052	6.29	0.700	0.212
Median ∑DDT (mg/kg)	0.028	0.016	0.182	0.016	--	0.513	0.096
Max ∑DDT (mg/kg)	0.354	0.106	0.391	0.228	21.0	4.09	1.88
Standard Deviation	0.102	0.031	0.132	0.068	6.18	0.646	0.360

[1] whole fish collected by MDWFP and USFWS between 1972 and 1988

[2] fillets collected by MDEQ and ERDC in 2000 and 2001

[3] fillets collected by ERDC in 2005

Costs of Restoring Upper Steele Bayou System


Legacy Pesticide Reduction
Fisheries Habitat & Sediment Control
Channel Excavation & Sediment Removal
Construction of Weirs & Drop Pipes
$ 22 million
$ 10 million
+ Associated project costs
+ Associated project costs
Total project cost
$ 35 million
Total cost per project mile: $ 500,000
Return on Investment: Restoration + Erosion and Flood Control

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Upper Steele Bayou Flood Control

Key Takeaway Points

- Flood control project incorporated ecosystem restoration by recognizing benefits of modified design
- Adaptive planning requires collaboration and balance of needs, opportunities, and costs
- Monitoring must be conducted at meaningful intervals to demonstrate success
- Model is applicable to comparable watersheds (highly degraded, low-gradient alluvial streams)

Acknowledgements

USACE Vicksburg District

Ecosystem Management & Restoration Research Program

MDEQ

USGS science for a changing world

DELTA COUNCIL

ULM WARHAWKS

MISSISSIPPI WILDLIFE, FISHERIES, & PARKS